PATENT ABSTRACTS OF JAPAN

(11)Publication number : 06-038957

(43)Date of publication of application : 15.02.1994

(51)Int.Cl. A61B 6/03

(21)Application number : 05-126019

(22)Date of filing : 27.05.1993

(71)Applicant : TOSHIBA CORP

(72)Inventor : KONAKAWA CHIEKO
NANBU KYOJIRO

(30)Priority

Priority number : 04135044 Priority date : 27.05.1992 Priority country : JP

(54) **CT APPARATUS**

(57)Abstract:

PURPOSE: To enable the use as back up for a bulb being used by making an optical system comprising a plurality of light sources not existing on the same plane and a detector operate independently or interlocking one another to enable scanning in a range within almost the same time by a helical dynamic scanning or on a plurality of photographing conditions.

CONSTITUTION: An X-ray CT apparatus has three X-ray tubes 3-1, 3-2 and 3-3 rotatable independently or interlocking one another at an interval parallel with one another and three detectors 4-1, 4-1 and 4-3 arranged corresponding to the individual X-ray tubes. Then, sets of the X-ray tubes and the detectors are allowed to rotate independent of other sets of X-ray tubes and detectors with a rotation control section 7.

When an error is generated during the scanning of the bulbs, scanning conditions are sent to other bulbs not used presently. Thus. the other bulbs can be used in stead.

LEGAL STATUS

[Date of request for examination]	26.05.2000
[Date of sending the examiner's decision of rejection]	
[Kind of final disposal of application other than the examiner's decision of rejection or application converted registration]	
[Date of final disposal for application]	
[Patent number]	3405760
[Date of registration]	07.03.2003
[Number of appeal against examiner's decision of rejection]	
[Date of requesting appeal against examiner's decision of rejection]	
[Date of extinction of right]	

CLAIMS

[Claim(s)]

[Claim 1] The CT scanner characterized by having the optical system which consists of two or more light sources which are not on the same flat surface, and two or more detectors formed to each light source, operating each optical system concerned by independence or linkage, respectively, and photoing a fault image.

[Claim 2] Two or more light sources arranged on the only spiral orbit set as the perimeter of analyte, The control means controlled that the pair of two or more detectors formed to said each light source, and a said each light source and a detector should be rotated with the same angular velocity, and said spiral orbit should be scanned in two or more optical system, The CT scanner characterized by having a means to create and display CT image constituted based on the data collected with said each detector.

[Translation done.]

DETAILED DESCRIPTION

[Detailed Description of the Invention]

[0001]

[Industrial Application] This invention relates to the CT scanner which has an X-ray detector corresponding to two or more light source (for example, X line source) and X line sources each.

[0002]

[Description of the Prior Art] While development of medical diagnostic equipment is furthered in recent years, many CT scanners which photo the tomogram for the part of the arbitration of analyte have come to be used. Moreover, in these days, in order to attain shortening of photography of a tomogram, the perimeter of analyte is scanned spirally and practical use is presented with the helical scan approach which computes the data of each slice location by interpolation processing, and reconfigurates a slice image based on this.

[0003] The conventional helical scan CT scanner revolved around the patient 70 on the berth 75 where one bulb 71 is movable in the direction of a body axis (analyte) continuously in accordance with the orbit 76, as shown in drawing 9 A, B, and C, and it was performing the spiral scan by the beam 72.

[0004]

[Problem(s) to be Solved by the Invention] However, it is in the conventional helical scan CT scanner (1). Since the number of bulbs is one, two or more scans in a certain time of day cannot be performed.

(2) It can scan only on one scan condition at once.

(3) If the heat capacity of optical system fills, it must wait until it cools down. Moreover, when it breaks down, time is taken in exchange of alternative optical system.

(4) Before a contrast medium goes away, it is necessary to scan for a short time but, and since there is only one bulb, it cannot scan in a short time.

(5) Since there is only one bulb, the large range cannot be scanned by fixed time amount. There was inconvenience to say.

[0005] It is made in view of the above-mentioned inconvenience, and this invention can be scanned helical dynamic, and the range can be scanned in the almost same time amount on two or more photography conditions, and it can use also as backup of a bulb in use, and it aims at offer of the CT scanner to which the scanning zone within unit time amount can be expanded.

[0006]

[Means for Solving the Problem] In order to attain the above-mentioned object, it is the description for this invention to have the optical system which consists of two or more light sources which are not on the same flat surface, and the detector formed to each light source, to operate each optical system concerned by independence or linkage, respectively, and to photo a fault image.

[0007] Moreover, two or more light sources arranged on the only spiral orbit set as the perimeter of analyte, The control means controlled that the pair of two or more detectors formed to said each light source, and a said each light source and a detector should be rotated with the same angular velocity, and said spiral orbit should be scanned in two or more optical system, It is characterized by having a means to create and display CT image constituted based on the data collected with said each detector.

[0008]

[Function] Like ****, in constituted this invention, two or more optical system which is not on the same flat surface is operated by independence or linkage, respectively, and it becomes possible to scan the same analyte. Therefore, if the same spiral orbit top is scanned by each optical system and it asks for the difference image, dynamic helical scan will become possible.

[0009] Moreover, it becomes possible to be able to photo a SUKYANO image simultaneously from a direction which is different to the same analyte using each optical system, for example, to obtain a top-bottom product image and a light-left image simultaneously. Furthermore, since a simultaneously different part can be scanned on the scan conditions which responded at least to each part, the abdomen of the same analyte and a thorax can be photoed simultaneously, for example.

[0010] Moreover, since it can back up in other optical system when the optical system of a piece breaks down, a diagnosis can be continued. Moreover, since the range can be shared and scanned using each optical system in case the fixed range is scanned, shortening of exposure time can be attained.

[0011]

[Example] Hereafter, the example of this invention is explained based on a drawing. Drawing 1 is the block diagram showing the rough configuration of the X-ray CT scanner concerning this invention.

[0012] The X-ray CT scanner shown in a drawing becomes independent or interlocks at parallel spacing mutually. Three pivotable bulbs (X-ray tube) 3-1, 3-2, and 3-3, 3 sets of detectors 4-1 formed corresponding to each bulb, 4-2, and 4-3, 3 sets of data collection sections 5-1 made into the form where it collects and is easy to process each projection data detected by each detector, 5-2, and 5-3, It has the stand (part of a broken line) 2 containing the optical-system position control section 8 which controls spacing of the roll control section 7 which controls the revolution of a bulb 3-1, 3-2, 3-3 and a detector 4-1, 4-2, and 4-3 and a bulb 3-1, 3-2, and 3-3.

[0013] The X-ray control section 6 by which an X-ray CT scanner controls X dosage which a bulb 3-1, 3-2, and 3-3 irradiate further, The controller 9 which controls the berth actuator 10 and the berth actuator 10 which drive a berth 11, It has the magnetic disk 16 which memorizes the keyboard 14, the internal memory 15, collection data, and the image data as the monitor 13 and scan condition input device which are connected to the CC section (CPU) 12 and the CC section 6 through a bus (not shown).

[0014] The CC section 12 controls the X-ray control section 6, the roll control section 7, the optical-system position control section 8, a controller 9, and an image re-component (not shown), and is superintending actuation of the whole X-ray CT scanner of this example. Moreover, the X-ray control section 6 controls the X-ray of each X-ray tube (bulb) of every under control of the CC section 12. And a certain X-ray tube (for example, X dosage in which other X-ray tubes (for example, bulb 3-2) carry out exposure to X dosage in which a bulb 3-1 carries out exposure can be made into an amount different, respectively.)

[0015] The roll control section 7 can perform the roll control of each X-ray tube and/or a detector to the bottom of control of the CC section 12, and the group of an X-ray tube and a detector can rotate it now independently with the group of other X-ray tubes and a detector by the roll control section 7. The optical-system position control section 8 controls the motion of the direction of a berth of each X-ray tube and a detector (a patient's (analyte) direction of a body axis) to the bottom of control of the CC section 12. An X-ray tube (bulb) is set to a scan starting position, and, specifically, it controls which X-ray tube is moved in the direction of a berth (a forward direction or negative direction) at the rate of about [which] how much among X-ray tube 3-1, 3-2, and 3-3. To the bottom of control of the CC section 12, a controller 9 makes the berth actuator 10 drive, and moves a berth 1 in a patient's direction of a body axis.

[0016] Drawing 2 is the block diagram showing the configuration of each control section shown in drawing 1, and the CC section 12 refers to the scan condition list 17 shown in this drawing. It is based on scan conditions. An instruction (signal) per bulb for the X-ray control section 6, the roll control section 7, the optical-system position control section 8, and a controller 9 Delivery, While controlling each [these] control sections 6, 7, 8, and 9, the information from each [these] control sections 6, 7, 8, and 9 and a detector 4-1, 4-2, and 4-3 (The amount of radioparency etc. is inputted [for example,] from each detector, such as a location (spacing) of an angle of rotation and optical system, and a location of a berth), and feedback control of each control sections 6, 7, 8, and 9 is carried out. Each control sections 6, 7, 8, and 9 perform revolution of the X-ray yield of each X line source, a bulb, and a detector and migration, and migration control of a berth based on the feedback control. In addition, it has a revolution driving gear (not shown) and migration equipment (not shown) for every group of each bulb and a corresponding detector, and a revolution and migration of a bulb and a detector are based on a driving signal from a roll control 7 and the optical-system control section 8, they become independent or interlock and drive them, respectively.

[0017] The scan condition list 17 is usually memorized by the magnetic disk 16, and if X-ray CT scanner 1 is started, although it is read into an internal memory 15 from a magnetic disk 16 and is referred to by the CC section 12, an operator can perform modification, an addition and registration, and deletion for the conditions of the scan condition list 17 from a keyboard 14. In this case, since the scan condition list 17 is displayed on a monitor 13 in a form as shown in drawing 2 , an operator can do the input of scan conditions simply. Moreover, scan conditions are stored according to a bulb, the number of a proper is beforehand assigned to the bulb, and the scan condition list 17 cannot change this number. The sign 17 of drawing 2 shows an example of a scan condition list. To the 1st line The condition graph of the 1st bulb 3-1 (-- for example, .. which uses this bulb .. of which 1; activity is not done -- 2; failure .. value) which shows the condition of the bulb 3 -- X filament affair (an X-ray electrical potential difference and current), a bulb, and the rotation of a detector (angle), Conditions (information), such as movement magnitude of a bulb and a detector, are stored. To the 2nd line The 2nd bulb 3-2, It is the 3rd bulb 3-3, and conditions (information), such as movement magnitude of the n-th status flag of bulb 3-n, X filament affair (an X-ray electrical potential difference and current), a bulb and the rotational speed of a detector, a bulb, and a detector, are stored in the 3rd line at the n-th line. As the X-ray source of release by the scan condition list, a bulb, and an example of actuation actuation of a detector For example, if the CC section reads the scan conditions "condition =1;120kV;

50mA;1rps;2mmps" of the 1st bulb 3-1 in a scan condition list and sends out the instruction (signal) based on the scan condition to each control sections 6, 7, and 8 An X-ray yield is controlled the X-ray control section 6 using supply voltage to the X-ray source of release of a bulb 3-1 to 120kV, and using a current as 50mA. The roll control section 7 an actuation control signal to a bulb 3-1 and the revolution driving gear of a detector 4-1 so that rotational speed of a bulb 3-1 and a detector 4-1 may be set to 1rps Delivery, The optical-system position control section 8 sends an actuation control signal to a bulb 3-1 and the migration equipment (not shown) of a detector 4-1 so that movement magnitude of a bulb 3-1 and a detector 4-1 may be set to 2mmps(es).

[0018] In this example, X-ray CT scanner 1 performs a spiral scan to analyte. Data restructuring equipment (not shown) incorporates the location data of the direction of a body axis of the group of data, and a berth 10 obtained by a detector 4-1, 4-2, and 4-3 by this spiral scan. From the incorporated data machine ****** interpolation processing (refer to JP,2-211129,A), it asks for the group of the interpolation data of the slice location of arbitration, and image reconstruction is performed based on the group of this interpolation data.

[0019] Supposing an error occurs in X line part of the 1st bulb (bulb 3-1) when an error arises during the scan of a bulb in this example for example, the X-ray control section 6 distinguishes from a status bit that the error occurred in the bulb 3-1, and a condition (status) bit is sent out to the CC section 12. The status bit consists of a bit flag which shows the specific number of a bulb, and the condition of a bulb. The CC section 12 investigates a status bit and sends out the disable code of a bulb 3-1 to the roll control section 7 and the optical-system position control section 8. The roll control section 7 and the optical-system position control section 8 send an actuation stop signal to the revolution driving gear and migration equipment of a bulb 3-1 and a detector 4-1. The scan conditions of the 1st bulb 3-1 etc. are used for delivery, and the CC section 12 uses the bulb for other bulbs by which a current activity is not carried out instead of a bulb 3-1, after checking that all motions of a bulb 3-1 have stopped.

[0020] The effectiveness of this example is explained below.

[0021] (**) A helical dynamic scan can be performed.

[0022] Helical scan is a method which scans analyte spirally, and can scan the large range quickly. Moreover, if it is the scanned range, it is made to an image in every part. On the other hand, a dynamic scan can observe and photo a change of a scan location with time by scanning a certain location continuously. and according to the CT scanner of this example, by the bulbs 31a-31c of plurality (drawing three pieces), as shown in drawing 3 (A), when the helical scan of the range d is carried out, it is shown in this

drawing (B) -- as -- each -- location P1 -P4 A change of the image which can be set with time can be seen. That is, a helical dynamic scan is attained.

[0023] Moreover, in case a difference image is created using a helical dynamic scan and aging of a contrast medium is observed, as shown in drawing 4 , it is necessary to make equal the orbit of each bulbs 31a-31c. About this, it can set up easily from the relation between spacing of Bulbs 31a-31c, and the feed rate of analyte. Moreover, in order to decide after how many seconds the same part of analyte is scanned, it can decide with spacing of Bulbs 31a-31c, and the mounting angle of Bulbs 31a-31c. Moreover, by shifting the mounting angle of Bulbs 31a-31c, as shown in drawing 5 , spacing h of Bulbs 31a-31c can be made narrower than the width of face of the bulb itself. If it is got blocked, for example, a mounting angle is not given when the radius of a bulb is 100 [mm], spacing of bulbs is 200 [at least] [mm] Needed, but if a mounting angle is given, this spacing can be carried out to more than 0 [mm].

[0024] And if such a helical dynamic scan is used, cinedisplay 34 which met a change with time by the three-dimension image as shown in drawing 3 (c) can be performed. Utilization with this display effective in for example, the brain surgery field is expected.

[0025] (**) On two or more photography conditions, the same range as the almost same time amount can be scanned.

[0026] For example, if analyte (patient) 40 is simultaneously scanned from the upper part and a side face by 2 sets of optical system 41 and 42 as shown in drawing 6 (A), the SUKYANO gram of a top-bottom product (top-bottom) image and a light-left (right-left) image as shown in drawing 6 (B) can be obtained. Moreover, the scan to which the rotational speed of a beam or optical system was changed for every optical system can be carried out in the same range almost simultaneous. And it can scan on the scan conditions which are different from each other before a contrast medium is spilt out by this. Moreover, it improves in a patient throughput and the burden to a patient is mitigated. And the time and effort rescanned when the time of wanting to change and scan conditions and photography go wrong can be saved. This is effective especially in the research which requires scanning on condition that versatility.

[0027] (**) Two or more parts can be simultaneously photoed on the scan conditions according to a part.

[0028] Two or more parts can be simultaneously scanned on the scan conditions according to a part. In the case of a mass screening etc., this is more effective. In this case, in drawing 7, a bulb 51 can scan a thorax and a bulb 52 can scan an abdomen. Since scan conditions are set to the conditions according to a part, respectively and these scans can moreover scan them simultaneously, they are possible, the exposure of

an X-ray can also be suppressed to necessary minimum, and moreover, a per capita scan time is short and ends. [of an exact diagnosis]
[0029] (**) Even when it becomes impossible to use a bulb in use, it can switch to other bulbs.
[0030] The key factor of the down time of conventional equipment is failure of a bulb. However, since there are two or more bulbs in this example, when the time of the capacity of a bulb filling and a bulb break down, the bulb which is not used and carried out can be used as a reserve. For this reason, the inspection with the need of using all bulbs simultaneously can continue inspection using the bulb in which the thing which becomes impossible remained. Therefore, there is no down time by failure of a bulb, and it can always respond to an urgent inspection.
[0031] (**) The fixed range can be scanned conventionally in a short time.
[0032] Drawing 8 (A) shows the conventional helical scan which performs a spiral scan by one bulb, and sets 1 time of the scan time in this case to t. On the other hand, drawing 8 (B) shows the case where the same part is scanned by two bulbs by this invention, and 1 time of the scan time in this case is set to 1/2t. Thus, when scanning by n optical system by this invention, a photograph can be taken by the time amount of the conventional 1/n. This is effective by the time of having to scan in a short time like, when a contrast medium is poured in.
[0033] (**) Spatial resolving power can be raised.
[0034] When photoing a homotype enclosure within a certain fixed time amount, since a photograph is taken by two or more optical system, the spatial resolving power of the direction which the scan was completed densely and met the body axis can be raised.
[0035] (g) A dual energy scan can be performed.
[0036] If the energy of the X-ray which is different from each other by two or more bulbs is made to use it, a dual energy scan will be attained easily.
[0037] That is, the image for every energy is obtained by photoing the same part with two or more kinds of X lineal energies. It can ask for the image which expresses electronic distribution density, extent of Compton scattering, and the photoelectric effect using these images by count. These serve as useful information, when presuming the elementary composition of a photographic subject. Since the ratios of the reinforcement of Compton scattering and the reinforcement of the photoelectric effect differ for every element, X-ray absorption is decided by the consistency of these two scattering effects and the matter.
[0038] In addition, this example is not limited to the above-mentioned example, and as shown in drawing 10 (A), it may scan by installing the gantries 65-67 of plurality

(drawing three pieces). With such a configuration, although spacing of each X-ray tube cannot be narrowed to some extent below, as shown in drawing 10 (B), the tilt of each gantries 65-67 can be carried out.

[0039]

[Effect of the Invention] Since according to this invention it has two or more X-ray tubes which are not on the same flat surface and these can be operated by independence or linkage as explained above, a helical dynamic scan is attained and a SUKYANO gram image can be obtained on two or more photography conditions. Furthermore, when other parts can be simultaneously photoed now on the scan conditions according to a part and one bulb breaks down, it becomes possible to back up by other bulbs.

[0040] Moreover, the fixed range can be scanned conventionally in a short time, and the effectiveness that a dual energy scan is attained is acquired.

[Translation done.]

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]

[Drawing 1] The conceptual diagram of the X-ray CT scanner which is one example of a CT scanner based on this invention.

[Drawing 2] An example of the block diagram of the control section in the example of drawing 1 and a scan condition list is shown.

[Drawing 3] A part drawing A shows an example of a helical dynamic scan, a part drawing B shows two or more head images photoed with time by the helical dynamic scan, and a part drawing C shows the example of the cinedisplay which met aging by the three-dimension image with a helical dynamic scan.

[Drawing 4] The example which doubled the bulb with the spiral orbit of helical scan is shown.

[Drawing 5] The example which shifted the mounting angle of each bulb is shown.

[Drawing 6]Part drawings A are two or more photography conditions, the example which scanned the same range as the almost same time amount is shown, and a part drawing B shows the image obtained as a result.

[Drawing 7] The example which scanned other parts on the scan conditions according to a part is shown simultaneously.

[Drawing 8]a part drawing A shows the helical scan since ** which performs a spiral scan by one bulb, and a part drawing B shows the case where the same part is scanned by two bulbs by this invention.

[Drawing 9]A part drawing A is a perspective view showing the example of the scan by the conventional helical scan CT scanner, a part drawing B is a side elevation and a part drawing C is drawing foreseen from the stand.

[Drawing 10] The example photoed using two or more gantries is shown.

[Description of Notations]

1 X-ray CT Scanner (CT Scanner)

2 Stand

3-1, 3-2, 3-3 Bulb

4-1, 4-2, 4-3 Detector

11 Berth

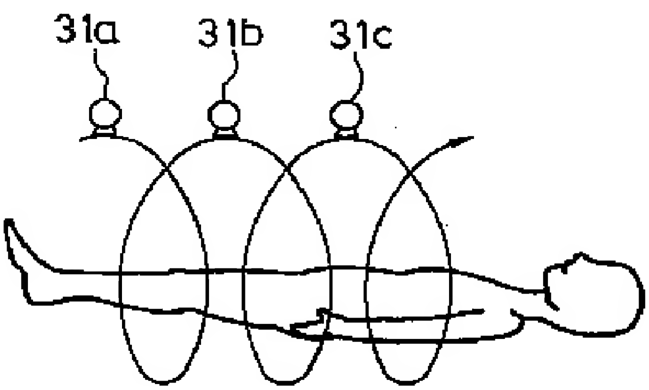
10 Berth Actuator

12 Control Section

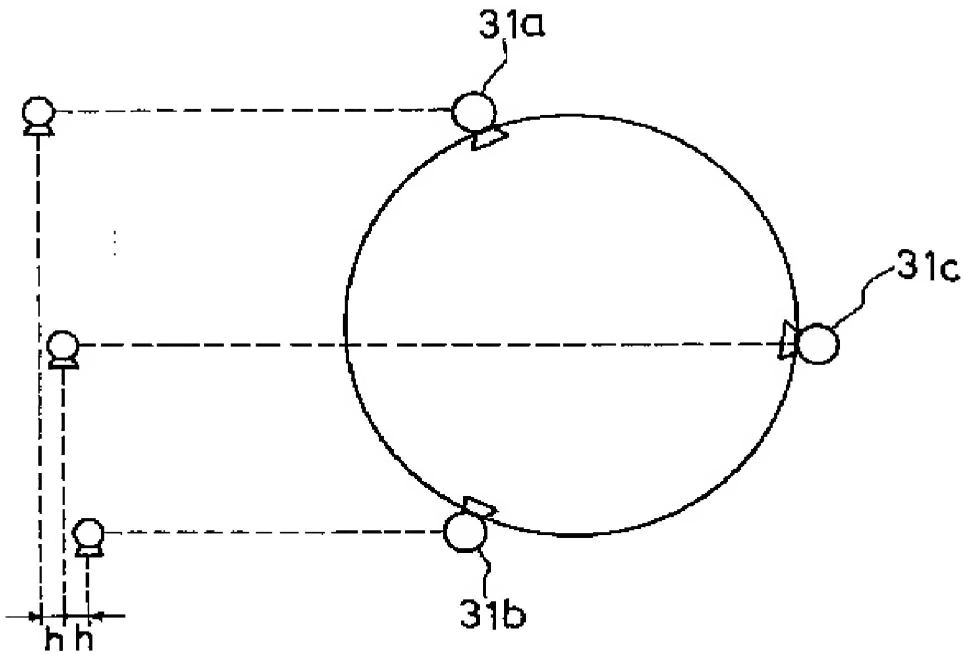
[Translation done.]

DRAWINGS

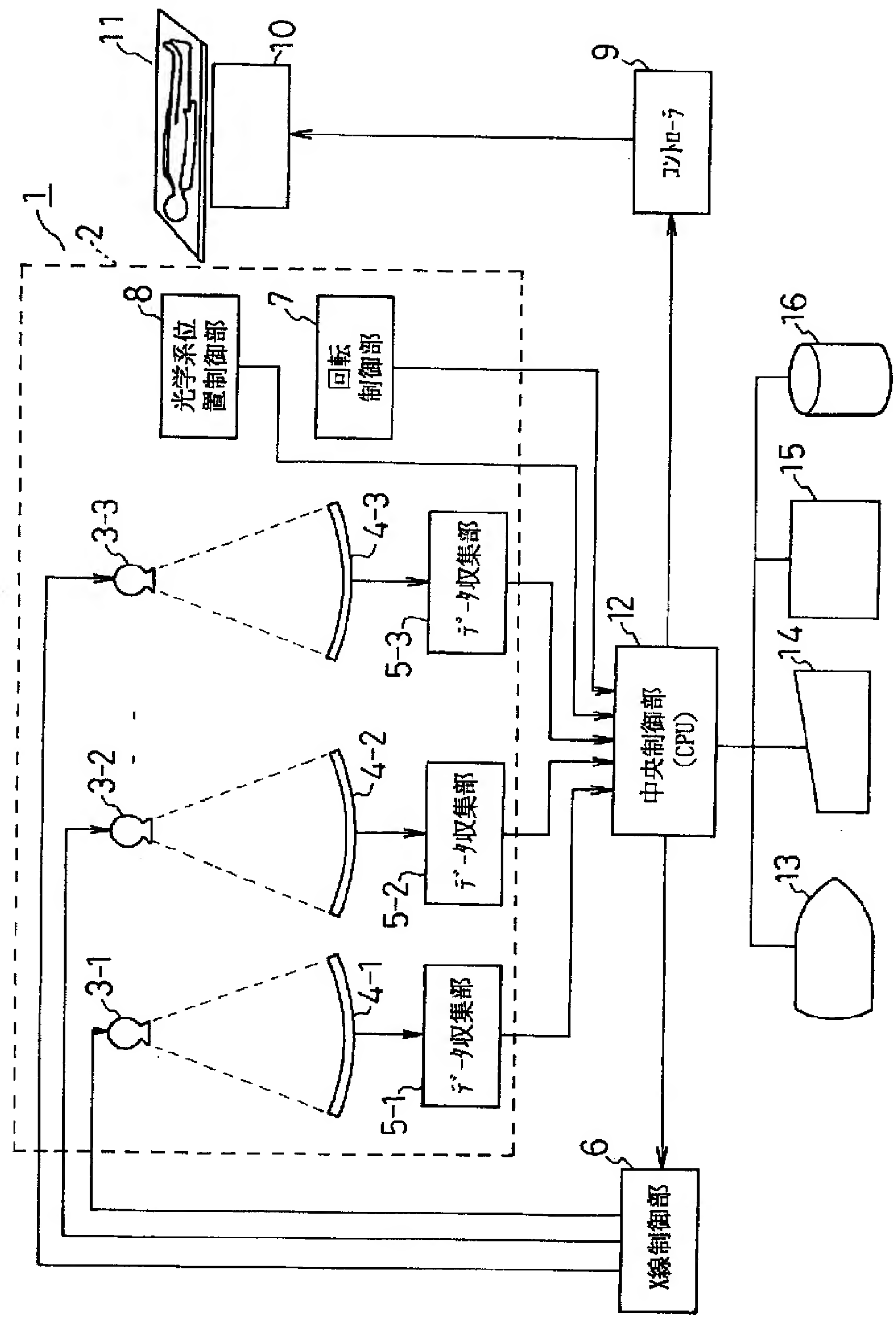
[Drawing 4]



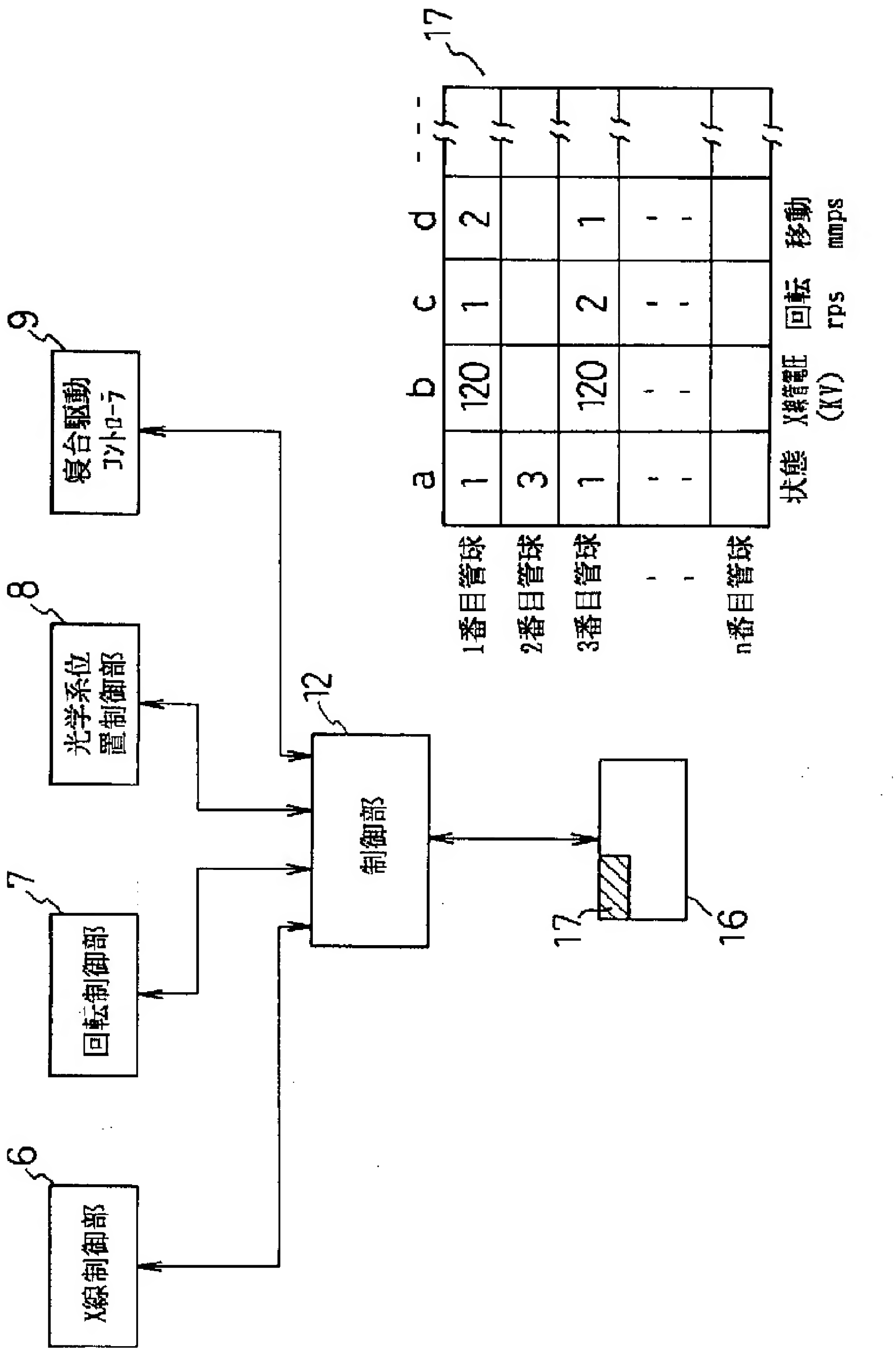
[Drawing 5]



[Drawing 1]

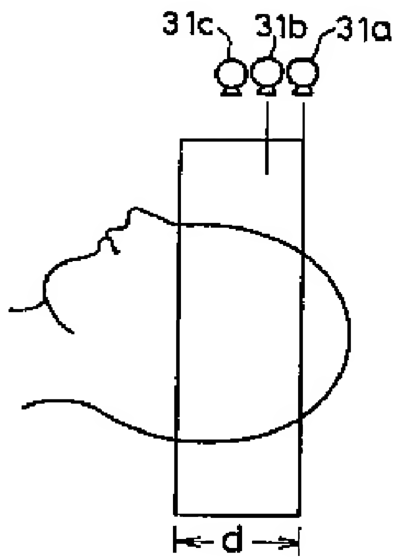

1
2
3-1
3-2
3-3
4-1
4-2
4-3
5-1
5-2
5-3
6
7
8
9
10
11
12
13
14
15
16
光学系位置制御部
回転制御部
データ収集部
データ収集部
データ収集部
中央制御部
(CPU)
X線制御部
コントローラ

[Drawing 2]

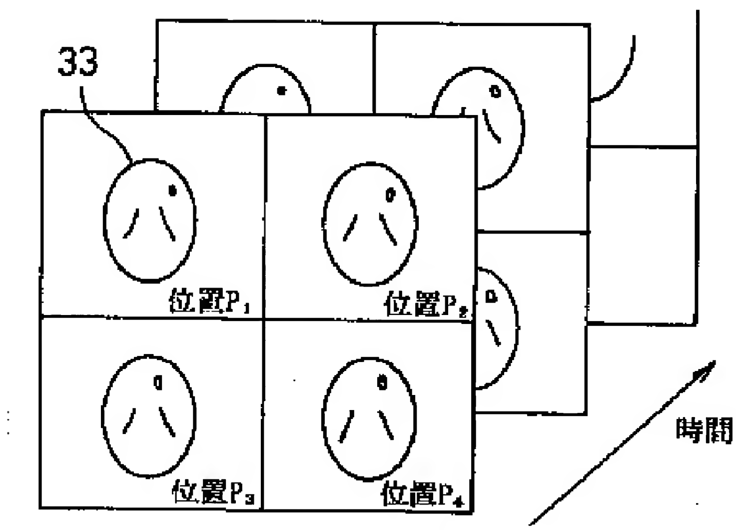

6
X線制御部
7
回転制御部
8
光学系位置制御部
9
寝台駆動コントローラ
12
制御部
16
17
a
b
c
d
1番目管球
2番目管球
3番目管球
n番目管球
1
120
1
2
3
1
120
2
1
状態
X線管電圧
(KV)
回転
rps
移動
mmps

[Drawing 3]

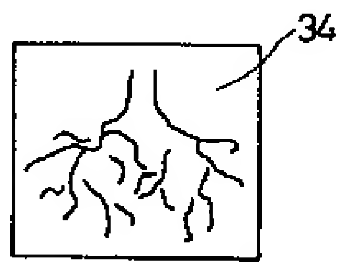
(A)



(B)

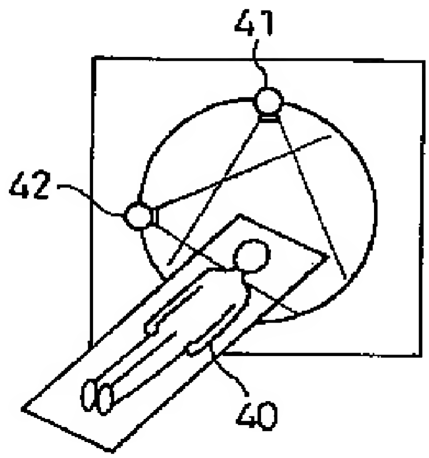


(C)

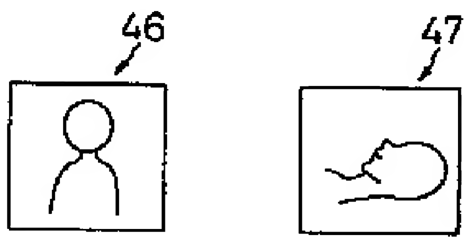


[Drawing 6]

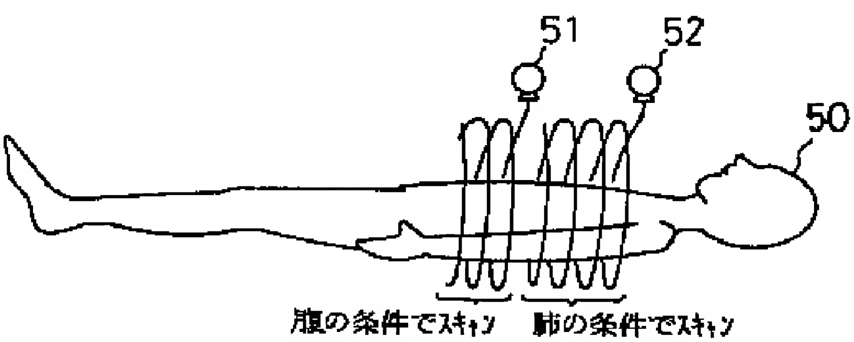
(A)



(B)

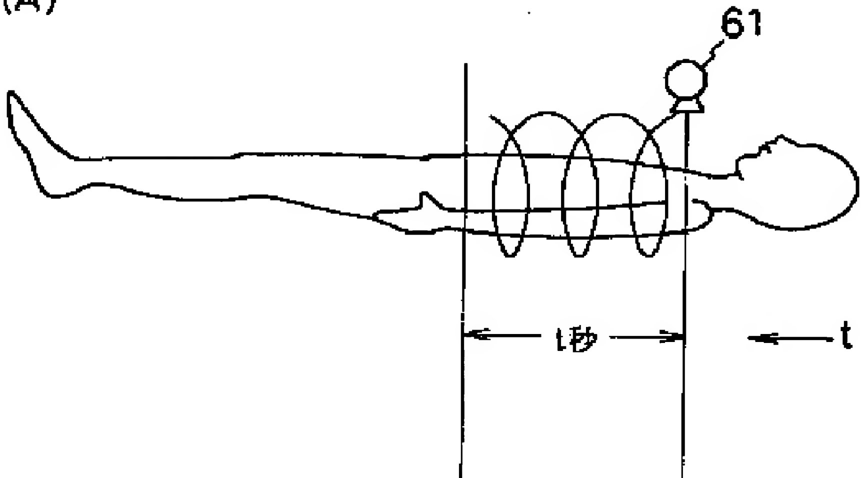


[Drawing 7]

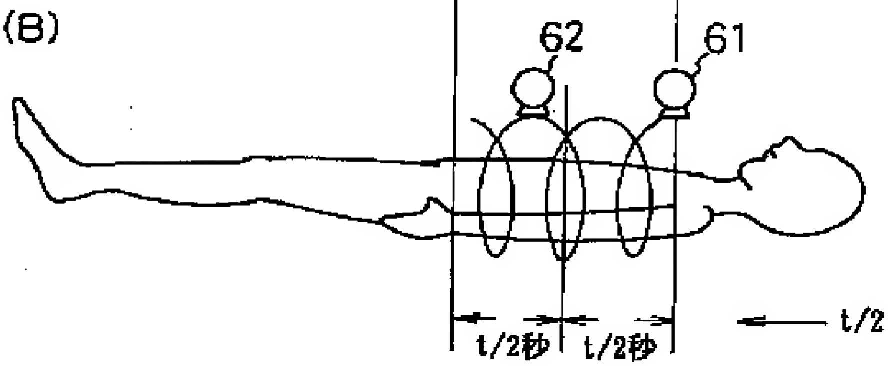


[Drawing 8]

(A)

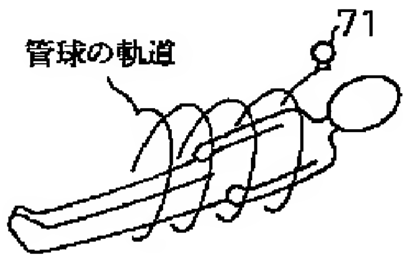


(B)

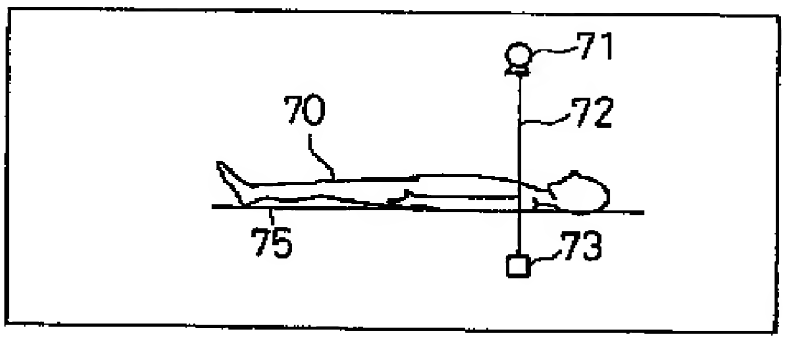


[Drawing 9]

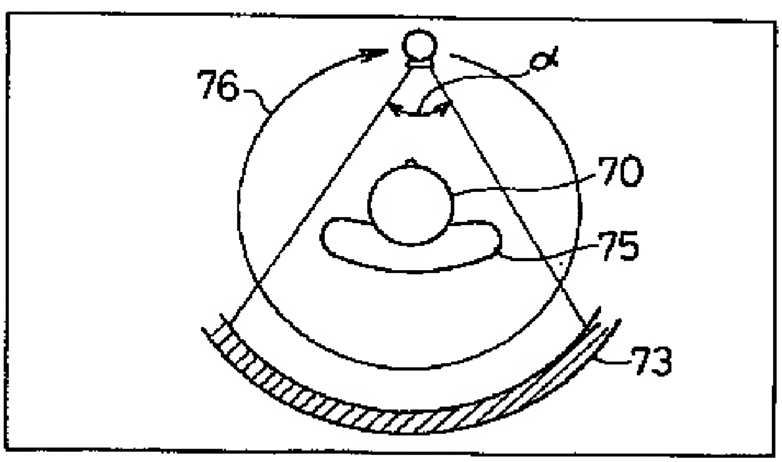
(A)



(B)

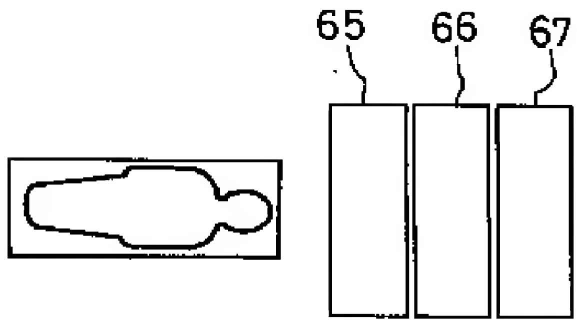


(C)

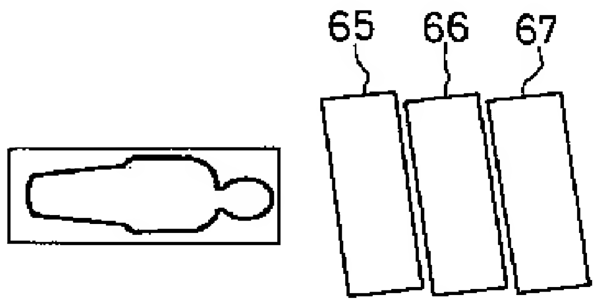


[Drawing 10]

(A)



(B)



[Translation done.]